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STATISTICAL QUALITY CONTROL AND TOTAL QUALITY MANAGEMENT USING SIX SIGMA APPROACH

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Abstract:
Industries are continuously facing fierce competition and the challenge of meeting increasing demands for higher quality products at economic costs. The success of an organization is directly related to how effective its implementation of continuous improvement (CI) is. For any manufacturing system, Total Quality Management (TQM) and Six Sigma are important CI methodologies. Effective understanding of these methodologies and their relationship will provide an industry with a competitive advantage. Many industrial organizations today are using either TQM or Six Sigma as the core for their CI efforts. There is a lot of disputes on which methodology is superior, how they relate to each other, what the common grounds are and what their differences are. As such, the relationship between TQM and Six Sigma is worth further investigation. Finally, this research Lean Six Sigma is an approach which focuses on continuous improvement of processes in order to reduce the cost due to poor quality and to make improvements in results to create value for the customers.

Index Terms **- Six Sigma, SQC, TQM.**

I. INTRODUCTION

Six sigma was developed at Motorola in the 1980's as a method of improve process quality. Sigma represents the standard deviation, a unit of measurement that designates the distribution or spread about the mean of a process (Six Sigma Academy, 2002). The role of continuous improvement within organizations has changed and matured throughout history. From the first improvements made through the invention of machines that sped up production to using empirical or statistical methods to analyze processes, individuals and organizations have pursued improved operating methods. Certain industries, such as healthcare and pharmaceuticals, focus the majority of their continuous improvement efforts on maximizing the quality of their products and services for others, continuous improvement is viewed as a mechanism for driving down cost.

In addition to cutting costs and improving quality, successful continuous improvement initiatives ultimately change the culture of an organization. The culture change focuses on the motivation and desire of the organization's members to continually improve business processes and policies. This fundamental change in operating and managing processes requires the stimulus of a structured method or program of continuous improvement.

Each of these methodologies has been individually popularized by successful implementations at companies such as Toyota, General Electric and Raytheon. Many companies are now recognizing the powerful synergy that is product when these two methodologies are combined and have successfully implemented lean or Six Sigma. However, these implementations were not without some difficulty. The experiences of the first implementations of Lean and Six Sigma Methodologies are unique based on leadership and culture. Subsequent implementations of Lean and Six Sigma have benefited from the literature and experiences produced by these pioneering companies.

1.1 THE EVOLUATION

As we know the origin of six sigma methodology is Motorola (Japan). Since then, it has been utilized thousands of well-known companies successfully. Well can divide users of Six Sigma approach into three Generations. Generation I Six Sigma focused on defect elimination and basic variability reduction, primarily in manufacturing. Motorola is a classic exemplar of Generation I Six Sigma. In Generation II Six Sigma, the emphasis on variability reduction and defect elimination remained, but now there was a strong effort to tie these efforts to projects and activity that improved business performance through improved design and cost reduction. General Electric is often cited as the leader of the Generation II phase of Six Sigma. In Generation III Six Sigma has the additional focus of creating value throughout the organization and for its stakeholder (owner's employees, customers, suppliers and society at large). Creating value can take many forms such as increasing stock price and dividends, job retention, expanding markets for company products/services, developing new product/services that reach new and broader markets and increasing the levels of customer satisfaction (perhaps by reducing cycle time or increasing throughput) throughout the range of products and services offered.

1.2 SIX SIGMA ACCORDING TO SOME OF THE PERSONALS

Six Sigma is a business strategy that seeks to identify and eliminate causes of errors or defects or failures in business processes by focusing on outputs that are critical to customers. It is a measure of quality that strives for near elimination of defects using the application of statistical methods. A defect is defined as anything which could lead to customer dissatisfaction. The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction.

Six Sigma is a business strategy that seeks to identify and eliminate causes of errors or defects or failures in business processes by focusing on output that are critical to customers.

Sigma Level	Defects Per Million Opportunities	Cost of Quality
2	308,357	(Noncompetitive companies) Not applicable
3	66,807	25-40% of sales
4	6,210	(Industry average) 15-25% of sales
5	233	5-15% of sales
6	3.4	(World class) <1% of sales

As we can observe in the above table 2σ means 308,357 defects per Million opportunities, which is relatively very high. We cannot afford such defective production. Similarly, 3σ means 66,807 defects per Million opportunities. This is also quite high amount defect.4σ means 6,210 defects per Million opportunities. This is all right for average industries. 5σ means 233 defects per Million opportunities, which is good but not excellent. When any defect is life costing than even this small margin of error is dangerous. Now 6σ means 3.2 defects per Million opportunities that is close to almost no defect. So, we can consider this as error free case.

II. LITERATURE REVIEW

The main objective of Six Sigma is to reduce variability in key product quality characteristics around specified target values to the level at which failure or defects are extremely unlikely. Six Sigma approach is used to minimize the variability of the process such that the specification limits remain six standard deviations away from the target.

Six Sigma quality level results about 3 parts per billion non-conforming to specifications. When we apply Six Sigma approach, the process mean is still subject to disturbances that could cause it to shift by as much as 1.5 standard deviations off target. In this situation Six Sigma process would produce up to 3.4 parts per million (ppm) non-confirming to specifications. Some have argued that there is an inconsistency in that we can only make predictions about process performance when the process is stable, i.e. the mean and standard deviation are constant over time. If the mean is drifting, a prediction of up to 3.4 ppm non-conforming to specifications may not be very reliable, because the mean might shift by more than then "allowed" 1.5 standard deviations. Process performance is not predictable unless the process behavior is stable.

The Six Sigma process concept is one way to model this behavior. Like all models, it is at best an approximation, but it can be a useful way to think about and quantify process performance. The 3.4-ppm metric, however, is increasingly recognized as primarily a distraction; it is the focus on reduction of variability about the target and the elimination of waste and defects that is the important feature of Six Sigma.

Six Sigma concepts come from statistics. A process which has a normal distribution is represented as a bell-shaped distribution, also called a Gaussian distribution.

The shape of this normal curve depends solely on the process, equipment, personnel, and so on, which can affect companies. This normal curve represents the spread of DOT (Delivery-on-time) resulting from daily delivery, using current equipment, materials, workers, and so forth. The normal curve says nothing about the range of DOT (Delivery-on-time) acceptable to the customer. This curve is the empirical quantification for the variability that exists within the DOT delivery process.

III. RESEARCH OBJECTIVE

The aim of the research is to company's beneficiate by Six Sigma approach and identify the impact of such an approach using statistical analysis.

Important research objectives of the study:

1. Comparative study of TQM and Six Sigma
2. Applications of Six Sigma in different industries
3. Effect of six sigma Approach in companies

3.1 RESEARCH PROBLEM

1. To solve real life issues
2. To reducing defects in set of processes
3. Six Sigma is useful for variations
4. Defect which arises due to multiple level of processing.

3.2 RESEARCH METHODOLOGY

There are two basic methodologies (although there are several derivations of each) described Six Sigma: DMAIC (Define, Measure, Analyze, Improve and Control), and DMADV (Define, Measure, Analyze, Design, and Verify). DMAIC (Define, Measure, Analyze, Improve and Control), is used to improve existing business processes and DMADV (Define, Measure, Analyze, Design, and Verify) is used when you are creating a new product, service, or design. Since we all have existing processes that can be improved let's take a closer look at the DMAIC (Define, Measure, Analyze, Improve and Control) Methodology. Measuring is not a goal itself, but improvement.

Six Sigma practitioners use Six Sigma to measure the capability of a process, but they also used specific tools for improving the level of quality, usually for decreasing the variation within processes (diminishing sigma and bringing processes at capability levels). Six Sigma has its own steps for improving a process capability, which are denoted by the acronym DMAIC (Define, Measure, Analyze, Improve and Control), established at Motorola.

DMAIC is recognized as a methodology to analyze processes in order to root out sources of unacceptable variation, and develop alternatives to eliminate or reduce errors and variation. A structured project approach and effective execution of the project are the keys to the success of the Six Sigma process.

Characteristics of Six Sigma include:

- Expected bottom line results delivered.
- Senior management leadership.
- A disciplined five step's approach using Define, Measure, Analyze, Improve and Control (DMAIC) concept.
- Rapid project completion.
- Clearly defined performance measurements.

3.3 PROCESS STEPS OF DMAIC METHODOLOGY

The DMAIC methodology uses a process-step structure. Steps generally are sequential; however, some activities from various steps may occur concurrently or may be iterative. Deliverables for a given step must be completed prior to formal gate review approval. Step Reviews do occur sequentially. The DMAIC five steps are

1. DEFINE: The problem and scope the work effort of the project team. The description of the problem should include the pain felt by the customer and/or business as well as how long the issue has existed. Hence, identify the customer(s), the project goals, and timeframe for completion.

The appropriate types of problems have unlimited scope and scale, from employee problems to issues with the production process or advertising. Regardless of the type of problem, it should be systemic—part of an existing, steady-state process wherein the problem is not a one-time event, but has caused pain for a couple of cycles.

2. MEASURE: The current process or performance. Identify what data is available and from what source. Develop a plan to gather it. Gather the data and summarize it, telling a story to describe the problem. This usually involves utilization of graphical tools.

3. ANALYZE: The current performance to isolate the problem. Through analysis (both statistical and qualitatively), begin to formulate and test hypotheses about the root cause of the problem.

4. IMPROVE: The problem by selecting a solution. Based on the identified root cause(s) in the prior step, directly address the cause with an improvement. Brainstorm potential solutions, prioritize them based on customer requirements, make a selection, and test to see if the solution resolves the problem.

5. CONTROL: The improved process or product performance to ensure the target(s) are met. Once the solution has resolved the problem, the improvements must be standardized and sustained over time. The standard-operating-procedures may require revision, and a control plan should be put in place to monitor ongoing performance. The project team transitions the standardized improvements and sustaining control plan to the process players and closes out the project.

A DMAIC project typically runs for a relatively short duration (three to nine months), versus product development projects (using UAPL or DFSS) and operational line management (using LMAD), which can run years. Given the relatively shorter duration to other types of Six Sigma methodologies, we distinguish the DMAIC as having five steps, rather than phases.

The DMAIC method is primarily based on the application of statistical process control, quality tools, and process capability analysis; it is not a product development methodology. It can be used to help redesign a process—any process, given that the redesign fixes the initial process problem.

IV. STATISTICAL QUALITY CONTROL

A system which performs inspection, testing and analysis using statistical methods to conclude whether the quality of each product is as per laid quality standard or not is called Statistical Quality Control". By using this process, we can make inspection more reliable and at the same time less costly. It is used to control the quality levels of the outgoing products.

"Statistical quality control" (SQC) means the application of statistical methods to control and measure systems. It is also found out the appropriate key input variable (KIV) SQC is associated with statistical process charting (SPC) methods. In SPC methods we have to create charts of products for visually measuring the consistency of key process outputs (KOVs). And also, to identifying unusual situation that might need attention.

Generally, SQC refers to many problem-solving methods. Some of these methods do not relate to monitoring or controlling processes and do not involve complicated statistical theory, SQC has become very popular in quality improvement projects with the statistics optimization methods. Design of experiment is also much used method for SQC.

As we have discussed in this chapter every organization has their own operative definition of quality according to conformance and fitness of use.

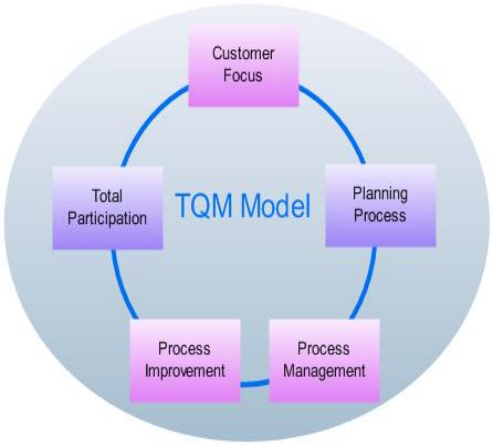
There is vast diversity in each method. Some of them needs complicated statistics and are simple choosing method. Some of the methods require single person for process are the other need team of e efficient& committed employees. There are few other

methods also used for SQC which is good to understand for more precise understanding. There are many methods to improve quality of process. But one of the most efficient one of them is Six-sigma approach.

V. CONCEPT OF TOTAL, OUALITY MANAGEMENT

INTRODUCTION: Around 1980s, U.S. corporations identified he quality achievements their Japanese parades and then they understand the importance of quality.

Then they utilized methods for improving the quality. They developed the awareness about quality in the employees for company's development. In many firms the TQM programs gave them excellent results. The basic objective of this technique was to improve quality of process and reduce total process time of the project. They have demonstrated improvement in achieving high quality, timely deliveries at low costs and ultimately improved their business performance. These firms called this new management and operations philosophy **Total Quality Management** or simply TQM.



In the beginning many TQM programs were simply copies of Japanese efforts. But in many organizations in US, they realized the cultural differences between Japan and US. So, they modify the TQM programs according to their culture, Motorola, created a very successful model that they termed "six sigma". Six sigma programs provide an infrastructure or quality improvement, including training programs. Motorola's successful deployment has been replicated by numerous other companies, including GE and Allied Signal. Other firms, frustrated by false starts and questionable implementations, began to question the value of total quality management, and some have given up, regarding it as just another fad (Senge, 1993). In many of these latter situations, quality efforts have been misdirected or unfocused. In some cases, quality improvement activities were simply knee-jerk reactions to the customers who complained most vehemently to the highest level of the organization Ram berg (1994) described some of the scurrilous characters who proclaim TOM, while delivering just another program, and raises the question, TQM: Thought Revolution or Trojan Horse"

While TQM connotes much more than simply the three words *total*, *quality* and management, nevertheless, definitions of each of the three words seem an appropriate place to begin. A typical dictionary definition of total is all or whole, that is constituting the whole complete. The definition of quality is a bit more difficult to comprehend as U.S. firms have come to understand. A formal definition, as given by the American Society for Quality (ASQC) and the American National Standards Institute (ANSI) is "The totality of and characteristics of a product or service that bear on its ability to satisfy stated or needs." Finally, management is the act, be it a science, an art or manner, of planning directing, organizing and controlling of a firm's decisions and actions. As an aside, it is interesting to note that the phrase "to manage" originated as "to train (a horse) in his paces, or to cause to do the exercises of the manage"

VI. COMPARISION OF TQM AND SIX SIGMA

Some contemporary articles have touted the demise and death of Total Quality Management (TQM). The basic tenants of TQM include strong customer focus, elevated employee involvement, continuous improvement, enlightened leadership and management by fact. There is concern, however, that TQM has lost its luster and has become less effective under the pressure of competing business priorities. This paper examines the problems associated with total quality management and suggests a revival under a newer name the rather odd statistical feature of the normal distribution known as ‘six-sigma.'

Problems Associated with TQM has been defined as 'managing the organization so that it excels in all dimensions of products and services that are important to the customers' (Chase et al., 2004: 274). To be effective, it is generally agreed that TQM requires an organization effort that includes continuous improvement, teamwork, and a customer focus. TQM has been a choice for managers and organizations for approximately two decades. Yet in the andmid-1990s, articles began to appear that questioned the value and efficacy of TQM in a number of organizations. Chang (1993) referred to its failure in many companies as being due to the onset of 'excessive activity syndrome.' He argued that, too often, companies tended to implement a wide range of activities without focusing on the outcomes achieved. Harari (1997) disclosed in an article originally published in 1993 that there are at least ten reasons why TQM doesn't work. "Quality operations,' he stated, 'often become so cumbersome that they overshadow the real reason a company is in business' (Harari, 1997: 38). According to independent research conducted by several consulting firms, less than one- third of TQM programs achieved significant or tangible improvements in quality or competitiveness. Among the reasons cited for TQM failure are excessive bureaucracy, focus on internal processes, and avoidance of genuine organizational reform, faddism, and lack of innovation within the corporate culture. [17] Suggested that hierarchical power structures and the pressures of capital accumulation restrict the operation of TQM. Lam parter (1997) stated emphatically that total quality management programs are dead, implying that a single-minded approach to improve quality ignored multi-faceted requirements to improve corporate performance. Dooley &Mahmoodi (1996) characterized the organizational frustration experienced when TQM efforts did not produce change as rapidly as leaders and change gents may have wished. Kolesar (1995) referred to a gap between what TQM practitioners espoused and what was actually being implemented. He identified a number of shortcomings that left many firms practicing only partial quality management.

INTEGRATION OF TQM AND SIX SIGMA

It has been suggested that the implementation of TQM results in an over-emphasis on customer satisfaction, with a relative neglect of the pursuit of profits (Anonymous, 1996). Indeed, several empirical studies have asserted that implementing TQM might not achieve any significant positive effect on profitability [11] [3]. Furthermore, [11] has noted that "What's good for the customer is not always good for the company".

The major problem with TQM is that there is a disconnection between management systems designed to measure customer satisfaction and those designed to measure business profitability, and this has often led to unwise investments in quality [3]. It should be recognized that the objective of TQM is to achieve customer satisfaction, in order to increase customer loyalty.

To sustain competitiveness and long-term profitability, companies not only devote themselves to attracting new customers, but also to retaining old customers in a continuous business relationship with incremental additional purchasing.

VII. EFFECT OF SIX SIGMA APPROACH IN DIFFERENT COMPANIES

(FROM DATA ANALYSIS OF ANNUAL REPORTS)

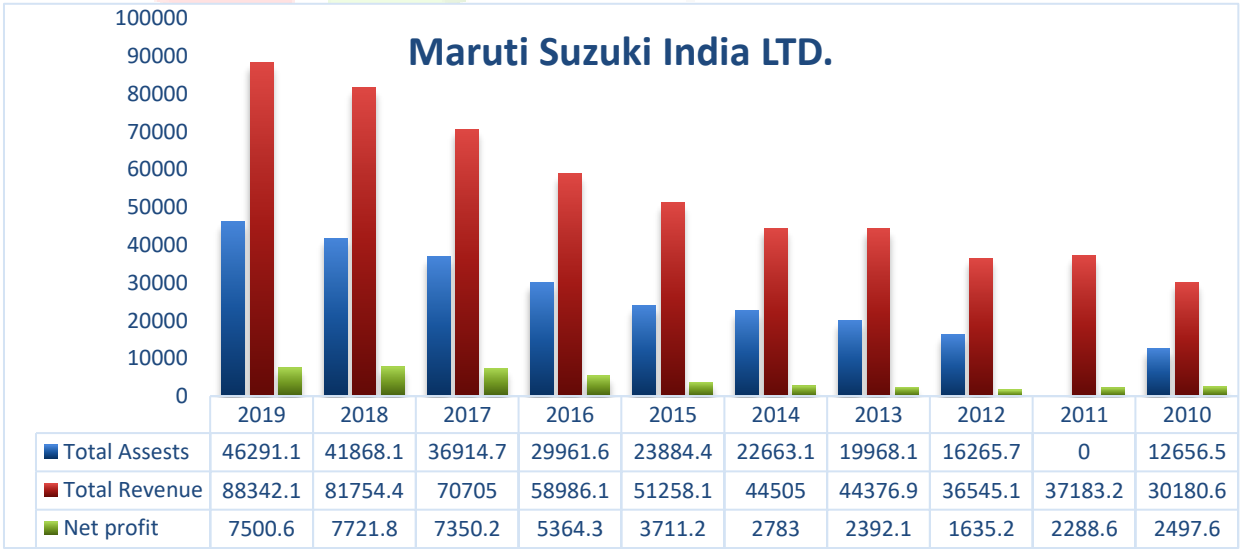
To understand the effect of Six Sigma approach I analyze some of the topmost companies of India. Hear I have taken secondary data from the annual reports of the companies. I observe annual reports of nine companies. Hear my aim is to do comparative study of companies' overall performance before and after applying Six Sigma approach upon it. I select companies from different fields like Automobile, Metal, Oil and Petroleum, Chemicals, Pharmaceuticals and Consumers Industry. In this chapter I will do comparative analysis of the company's performance after applying Six Sigma. Hear we consider 7 main variables for analysis. Among them four are values and three are ratios. The variables which we select for analysis are as follows:

1. Total Assets
2. Total Revenue
3. Net Profit
4. Cost of Good Sold
5. Total Assets Turnover Ratio
6. Net Profit Margin Ratio
7. Sales Per Employee Ratio

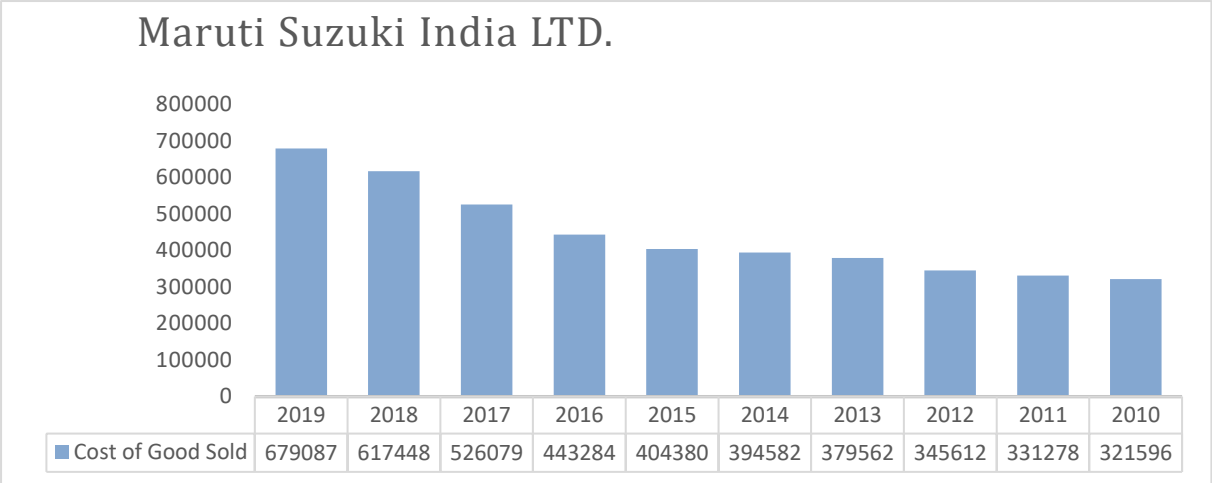
Among these seven variables first four are values and last three are ratios. We will use tabular and graphical representation to compare these variables for different years. In next chapter we will discuss some of the findings on the basis of this analysis and then construct conclusion. For graphical representation we use Histogram for easy comparison.

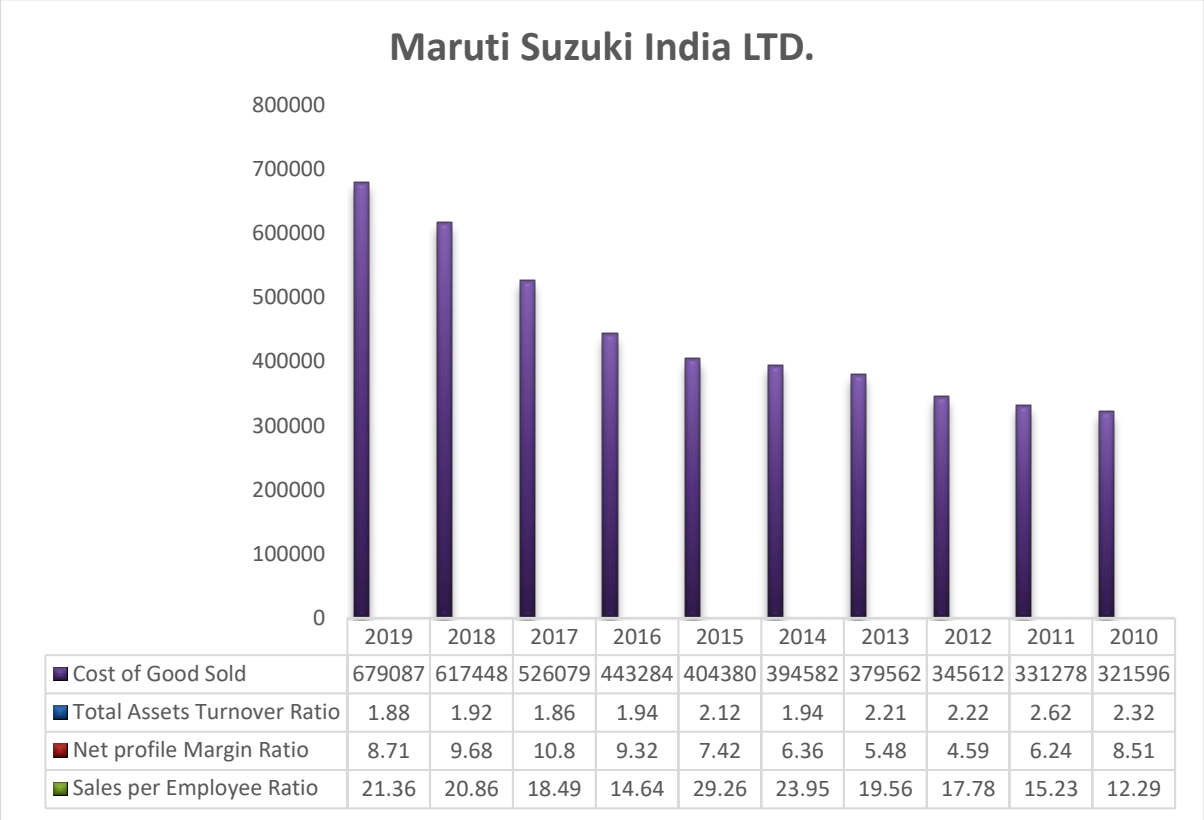
7.1 Data analysis: Maruti Suzuki India ltd (532500: Automobile)

Year	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
Total Assets	46291.1	41868.1	36914.7	29961.6	23884.4	22663.1	19968.1	16265.7	14.37.70	12656.5
Total Revenue	88342.1	81754.4	70705	58986.1	51258.1	44505	44376.9	36545.1	37183.2	30180.6
Net Profit	7500.6	7721.8	7350.2	5364.3	3711.2	2783	2392.1	1635.2	2288.6	2497.6
Cost Of Good Sold	679087	617448	526079	443284	404380	394582	379562	345612	331278	321596
Total Assets Turnover Ratio	1.88	1.92	1.86	1.94	2.12	1.94	2.21	2.22	2.62	2.32
Net Profit Margin Ratio	8.71	9.68	10.8	9.32	7.42	6.36	5.48	4.59	6.24	8.51
Sales Per Employee Ratio	21.36	20.86	18.49	14.64	29.26	23.95	19.56	17.78	15.23	12.29



	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
Total Assests	46291.1	41868.1	36914.7	29961.6	23884.4	22663.1	19968.1	16265.7	0	12656.5
Total Revenue	88342.1	81754.4	70705	58986.1	51258.1	44505	44376.9	36545.1	37183.2	30180.6
Net profit	7500.6	7721.8	7350.2	5364.3	3711.2	2783	2392.1	1635.2	2288.6	2497.6





AVERAGE	AFTER	SIX - SIGMA YEAR	BEFORE
Total Assets	46291.1	41,868.1	20289.26
Total Revenue	88342.1	81,754.40	46717.5
Net - Profit	7500.6	7,721.80	3502.775
Cost of Good Sold	679087	612,375	393296.6
Total Assets Turnover Ratio	1.88	1.92	2.153
Net Profit Margin Ratio	8.71	9.68	7.34
Sales per Employee Ratio	21.36	20.86	18.9

FINDINGS

(i) TOTAL ASSETS: As we can observe that average value of total assets before applying Six Sigma is 20289.26. After applying Six Sigma we can observe significant improvement in the value of total assets as it becomes 46291.1. So, we can say that there is definite improvement in assets.

(ii) TOTAL REVENUE: Average value of Total Revenue before applying Six Sigma is 46717.5. And after applying Six Sigma it improves and becomes 88342.1. So, we can say that there is significant increase in Total Revenue of the company after applying Six Sigma approach.

(iii) COST OF GOODS SOLD: The average Cost of Goods Sold before applying Six Sigma was 393296.6. After applying Six Sigma approach it became 679087.00. Here also we analyze significant improvement in the value of variable after applying Six Sigma approach.

(iv) AVERAGE EFFICIENCY OF THE COMPANY: We can compare average efficiency of the company on the basis of values of ratios. Here we can observe that out of three values of ratios one value is significantly improved after applying Six Sigma. Here

Sales per Margin Ratio increased significantly. But we can ignore it as other two ratio's values are not increased significantly. So overall there is improvement in the company's performance.

7.2 JINDAL STEEL & POWER LIMITED (532286: METAL)

AVERAGE	AFTER	SIX - SIGMA YEAR	BEFORE
Total Assets	40143.93	4413.8	32449.37
Total Revenue	26441.75	17000.3	12509.58
Net - Profit	262.9	361.61	1406.826
Cost of Good Sold	6876.55	6775.86	2710.55
Total Assets Turnover Ratio	0.69	0.39	0.4125
Net Profit Margin Ratio	0.94	2.11	10.28875
Sales per Employee Ratio	2.12	2.05	0.76625

FINDINGS

(i) TOTAL ASSETS: As we can observe that average value of total assets before applying Six Sigma is 32449.37. After applying Six Sigma we can observe significant improvement in the value of total assets as it becomes 40143.93. So, we can say that there is definite improvement in total assets.

(ii) TOTAL REVENUE: Average value of Total Revenue before applying Six Sigma is 12509.58. And after applying Six Sigma it improves and becomes 26441.75. So, we can say that there is significant increase in Total Revenue of the company after applying Six Sigma approach.

(iii) COST OF GOODS SOLD: The average Cost of Goods Sold before applying Six Sigma was 2710.55. After applying Six Sigma approach it became 6876.55. Here also we analyze significant improvement in the value of variable after applying Six Sigma approach.

(iv) AVERAGE EFFICIENCY OF THE COMPANY: We can compare average efficiency of the company on the basis of values of ratios. Here we can observe that out of three values of ratios two values are significantly improved after applying Six Sigma. Only Net Profit Margin Ratio deceased. Market competition may be one of the main reasons for that. But we can ignore it as other two ratio's values are increased significantly. So overall there is improvement in the company's performance.

7.3 HINDUSTAN PETROLEUM CORPORATON LIMITED (500104: OIL & PETROLEUM)

AVERAGE	AFTER	SIX - SIGMA YEAR	BEFORE
Total Assets	53285.15	43541.18	38045.07
Total Revenue	279015	220434.19	179624.5
Net - Profit	6028.66	6357.07	2399.386
Cost of Good Sold	48756	47865	44807.25
Total Assets Turnover Ratio	5.21	5.09	4.71
Net Profit Margin Ratio	2.19	2.89	1.35625
Sales per Employee Ratio	14.56	12.32	7.90625

FINDINGS

(i) TOTAL ASSETS: As we can observe that average value of total assets before applying Six Sigma is 38045.07. After applying Six Sigma we can observe significant improvement in the value of total assets as it becomes 53285.15. Here also we analyze significant improvement in the value of variable after applying Six Sigma approach.

(ii) TOTAL REVENUE: Average value of Total Revenue before applying Six Sigma is 179624.5. And after applying Six Sigma it improves and becomes 279015. So, we can say that there is significant increase in Total Revenue of the company after applying Six Sigma approach.

(iii) COST OF GOODS SOLD: The average Cost of Goods Sold before applying Six Sigma was 44807.25. After applying Six Sigma approach it became 48756. So, we can say that there is definite improvement in total assets.

(iv) AVERAGE EFFICIENCY OF THE COMPANY: We can compare average efficiency of the company on the basis of values of ratios. Here we can observe that out of three values of ratios two values are significantly improved after applying Six Sigma. Only Net Profit Margin Ratio deceased. Market competition may be one of the main reasons for that. But we can ignore it as other two ratio's values are increased significantly. So overall there is improvement in the company's performance.

7.4 TATA CHEMICALS LIMITED (500770: CHEMICALS)

AVERAGE	AFTER	SIX - SIGMA YEAR	BEFORE
Total Assets	11810.66	12005.82	8623.031
Total Revenue	4537.8	3660.5	7908.628
Net - Profit	909.74	1766.96	488.2125
Cost of Good Sold	65876	57395	71471.88
Total Assets Turnover Ratio	0.35	0.29	0.87625
Net Profit Margin Ratio	22.29	50.97	8.4975
Sales per Employee Ratio	2.42	2.39	1.4525

FINDINGS

(i) TOTAL ASSETS: As we can observe that average value of total assets before applying Six Sigma is 8623.031. After applying Six Sigma we can observe significant improvement in the value of total assets as it becomes 11810.66. Here also we analyze significant improvement in the value of variable after applying Six Sigma approach.

(ii) TOTAL REVENUE: Average value of Total Revenue before applying Six Sigma is 908.628. And after applying Six Sigma it improves and becomes 4537.8. So, we can say that there is significant increase in Total Revenue of the company after applying Six Sigma approach.

(iii) COST OF GOODS SOLD: The average Cost of Goods Sold before applying Six Sigma was 71471.88. After applying Six Sigma approach it became 65876. So, we can say that there is definite improvement in total assets.

(iv) AVERAGE EFFICIENCY OF THE COMPANY: We can compare average efficiency of the company on the basis of values of ratios. Here we can observe that out of three values of ratios two values are significantly improved after applying Six Sigma. Only Net Profit Margin Ratio decreased. Market competition may be one of the main reasons for that. But we can ignore it as other two ratio's values are increased significantly. So overall there is improvement in the company's performance.

7.5 JUBILANT LIFE SCIENCES LTD (530019: PHARMACEUTICALS)

AVERAGE	AFTER	SIX - SIGMA YEAR	BEFORE
Total Assets	3942.6	3499.41	4226.53
Total Revenue	3515.61	3352.54	2829.368
Net - Profit	147.63	263.44	109.5775
Cost of Good Sold	68072	56455	45457
Total Assets Turnover Ratio	0.87	0.95	0.68375
Net Profit Margin Ratio	4.29	7.96	5.56875
Sales per Employee Ratio	6.11	6.09	3.61725

FINDINGS

(i) TOTAL ASSETS: As we can observe that average value of total assets before applying Six Sigma is 4226.53. After applying Six Sigma we can observe significant improvement in the value of total assets as it becomes 3942.6. Here also we analyze significant improvement in the value of variable after applying Six Sigma approach.

(ii) TOTAL REVENUE: Average value of Total Revenue before applying Six Sigma is 2829.36. And after applying Six Sigma it improves and becomes 3515.61. So, we can say that there is significant increase in Total Revenue of the company after applying Six Sigma approach.

(iii) COST OF GOODS SOLD: The average Cost of Goods Sold before applying Six Sigma was 45457. After applying Six Sigma approach it became 68072. So, we can say that there is definite improvement in total assets.

(iv) AVERAGE EFFICIENCY OR THE COMPANY: We can compare average efficiency of the company on the basis of values of ratios. Here we can observe that out of three values of ratios one value is significantly improved after applying Six Sigma. Here Sales per Margin Ratio increased significantly. But we can ignore it as other two ratios values remain almost same So overall there is improvement the company performance.

7.6 ITC LIMITED (500875: CONSUMER INDUSTRIES)

AVERAGE	AFTER	SIX - SIGMA YEAR	BEFORE
Total Assets	69797.92	62381.31	37372.33
Total Revenue	47480.19	42757.38	31387.8
Net - Profit	12464.32	11223.25	7633.49
Cost of Good Sold	258672	232101	205213.8
Total Assets Turnover Ratio	0.78	0.8	1.24875
Net Profit Margin Ratio	27.7	27.62	24.91
Sales per Employee Ratio	1.42	1.37	0.82125

FINDINGS

(i) TOTAL ASSETS: As we can observe that average value of total assets before applying Six Sigma is 37372.33. After applying Six Sigma we can observe significant improvement in the value of total assets as it becomes 69797.92. Here also we analyze significant improvement in the value of variable after applying Six Sigma approach.

(ii) TOTAL REVENUE: Average value of Total Revenue before applying Six Sigma is 31387.8. And after applying Six Sigma it improves and becomes 47480.19. So, we can say that there is significant increase in Total Revenue of the company after applying Six Sigma approach.

(iii) COST OF GOODS SOLD: The average Cost of Goods Sold before applying Six Sigma was 205213.8. After applying Six Sigma approach it became 258672. So, we can say that there is definite improvement in total assets.

(iv) AVERAGE EFFICIENCY OR THE COMPANY: We can compare average efficiency of the company on the basis of values of ratios. Here we can observe that out of three values of ratios two values are significantly improved after applying Six Sigma. Only Total Assets Turnover Ratio decreased. Market competition may be one of the main reasons for that. But we can ignore it as other two ratio's values are increased significantly. So overall there is improvement in the company's performance.

VIII. FINAL CONCLUSIONS

We can observe in findings that out of 10 companies which we have taken for research, 9 companies are highly beneficiate by Six Sigma approach. So, we can conclude that this approach gives us guarantee results. We can improve not only quality of product but also sale of the product by applying this approach.

The findings of this research also suggest that a successful Six Sigma implementation should build upon a number of quality management prerequisites such as an existing quality culture and a certain level of quality maturity. The sustainability of Six Sigma in the long term depends on many factors such as top management commitment, being able to show successful projects, high investment in training, high investment in management time, and involvement of key players in the organization. Six Sigma can revolutionize an organization and it will go deep into its fabric and therefore needs top management drive behind it. It must be seen as part of a total approach, and it demands a level of quality competence from the organization before the benefits can begin to be delivered. Quality improvement methods such as Six Sigma may be very powerful but they have to be directed and need a clear strategy to measure and interpret its customers' needs successfully. Respondents realize that, if their organization has no clear power structure and the desired level of competence is not present, then a Six Sigma programmed is unlikely to work.

So basically, Six Sigma approach is not some kind of magic which will improve company's performance overnight but it is a methodology which can give you good results if you are committed to it.

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